Code No: RR311102 **Set No. 1**

III B.Tech I Semester Supplimentary Examinations, November 2007
DIGITAL SIGNAL PROCESSING
(Common to Bio-Medical Engineering and Electronics & Computer Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Let e(n) be an exponential sequence $e(n) = \alpha^n$ for all 'n' and let x(n) and y(n) be two arbitrary sequences. Show that [e(n)y(n)]* [e(n)x(n)]=e(n)[y(n)*x(n)]where '*' denotes convolution operation.
   (b) A system is described by the difference equation y(n)-y(n-1)-y(n-2) = x(n-1). Assuming that the system is initially relaxed, determine it s unit sample response h(n). [8+8]

2. Consider two periodic sequences x(n) and y(n), x(n) has period N and y(n) has period M. The sequence w(n) is defined as w(n) = x(n) + y(n).
   (a) Show that w(n) is periodic with period MN.
   (b) Determine W(K) in terms X(K) and Y(K) where X(K), Y(K) and W(K) are the Discrete Fourier series coefficients with a period of N, M and MN respectively. [8+8]

3. (a) Compute the discrete Fourier transform of each of the following finite length sequences considered to be of length N.
      i. $x(n) = \delta(n)$
      ii. $x(n) = \delta(n - n_0) where 0 < n_0 < N$
      iii. $x(n) = a^n 0 \leq n \leq N - 1$
   (b) Let $x_2(n)$ be a finite duration sequence of length N and $x_1(n) = \delta(n - n_0)$ where $n_0 < N$. Obtain the circular convolution of two sequences. [8+8]

4. (a) Implement the Decimation in frequency FFT algorithm of N-point DFT where N-8. Also explain the steps involved in this algorithm.
   (b) Compute the FFT for the sequence x(n) = { 1, 1, 1, 1, 1, 1, 1, 1 } [8+8]

5. (a) Explain how the analysis of discrete time invariant system can be obtained using convolution properties of Z transform.
   (b) Determine the impulse response of the system described by the difference equation y(n)-3y(n-1)-4y(n-2)=x(n)+2x(n-1) using Z transform. [8+8]

6. Determine the system function H(Z) of the lowest order Chebyshev and Butterworth digital filter with the following specification
   (a) 3 db ripple in pass band $0 \leq w \leq 0.2\pi$

(b) 25 db attenuation in stop band $0.45\pi \leq w \leq \pi$ [16]

7. (a) Explain briefly the method of designing FIR filter using Fourier series method

(b) Design a FIR filter approximating the ideal frequency response

$H_d(e^{j\Omega}) = \begin{cases} e^{-j\alpha\Omega}, & for\ |\Omega| \leq \pi/6 \\ 0 \quad , & for\ \pi/6 \leq |\Omega| \leq \pi \end{cases}$

Determine the filter coefficients for N=13. [6+10]

8. (a) List the different types of structures for realizing FIR system and determine the direct form-I, direct form II of the following LTI system
y(n)=-0.5y(n-1)+0.25y(n-2)+0.125y(n-3)+x(n)+0.5x(n-1)+0.75x(n-2)

(b) Write briefly about digital processing of speech. [6+10]

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Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
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1. (a) A discrete time system can be
   i. static or dynamic
   ii. linear or non linear
   iii. causal or non causal
   iv. stable or unstable
   Examine the following with respect to the properties above.
   y(n) = cos x(n)
   y(n) = x(-n+2)
   y(n) = x(-n)

   (b) Determine the impulse response and unit step response of the system described by the difference equation.
   i. y(n) = 0.6y(n-1)-0.08 y(n-2) +x(n)
   ii. y(n) = 0.7 y(n-1)-0.1y(n-2)+2x(n)-x(n-2) [8+8]

2. (a) If x(n) $\rightarrow x(e^{j\omega})$ Constitute a Fourier transform pair. Prove the following:

Sequence	Fourier Transform
i. x*(n)	$X*(e^{-j\omega}$
ii. $x_o(n)$	$jIm[X(e^{j\omega}]$

   (b) Let x(n) and $X(e^{j\omega})$ represent a sequence and its transform. Determine, in terms of $X(e^{j\omega})$, the transform of each of the following sequences :
   i. $g(n) = \begin{cases} x(n/2) & n\ even \\ 0 & n\ odd \end{cases}$
   ii. $x^2(n)$

   [8+8]

3. (a) Compute the discrete Fourier transform of each of the following finite length sequences considered to be of length N.
   i. $x(n) = \delta(n)$
   ii. $x(n) = \delta(n - n_0) where 0 < n_0 < N$
   iii. $x(n) = a^n 0 \leq n \leq N-1$

   (b) Let $x_2(n)$ be a finite duration sequence of length N and $x_1(n) = \delta(n - n_0)$ where $n_0 < N$. Obtain the circular convolution of two sequences. [8+8]

4. (a) Draw the butterfly line diagram for 8 - point FFT calculation and briefly explain. Use decimation -in-time algorithm.
   (b) What is FFT? Calculate the number of multiplications needed in the calculation of DFT using FFT algorithm with 32 point sequence. [8+8]

5. (a) An LTI system is described by the equation y(n)=x(n)+0.81x(n-1)-0.81x(n-2)-0.45y(n-2). Determine the transfer function of the system. Sketch the poles and zeroes on the Z-plane.
   (b) Define stable and unstable system test the condition for stability of the first-order IIR filter governed by the equation y(n)=x(n)+bx(n-1). [8+8]

6. (a) Explain the relation between analog and digital filters poles in IIM of transformation.
   (b) Discuss the Aliasing effect due to impulse invariance transformation (IIM)
   (c) Explain the method of determination of pole locations on an ellipse with major axis 'R' and minor axis 'r' for Chebyshev filter. [4+8+4]

7. (a) Design a low pass digital FIR filter using Kaiser window satisfying the specifications given below.
   Pass band cut-off frequency = 150 Hz.
   Stop band cut-off frequency = 250 Hz.
   Pass band ripple = 0.1dB
   Stop band attenuation = 40 dB
   Sampling frequency = 1000 Hz.
   (b) Draw the butterfly line diagram for 8 - point FFT calculation and briefly explain. Use decimation -in-time algorithm. [8+8]

8. (a) Describe how targets can be decided using RADAR
   (b) Give an expression for the following parameters relative to RADAR
      i. Beam width
      ii. Maximum unambiguous range
   (c) Discuss signal processing in a RADAR system. [4+6+4]

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Code No: RR311102 **Set No. 3**

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Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
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1. (a) Verify whether the following sequence is periodic or not, if periodic find the fundamental period.
   i. $x(n) = e^{j(n/8-\pi)}$
   ii. $x(n) = cos(\pi n^2/8)$
   (b) Show that an LSI system can described by its unit sample response. [10+6]

2. (a) If $x(n) \rightarrow x(e^{j\omega})$ Constitute a Fourier transform pair. Prove the following:

Sequence	Fourier Transform
i. x*(-n)	$X*(e^{j\omega})$
ii. j Im[x(n)]	$X_0(e^{j\omega})$

   (b) Prove that the convolution in time domain leads to multiplication in frequency domain for discrete time signals. [8+8]

3. (a) Define DFT of a sequence x(n). Obtain the relationship between DFT and DTFS.
   (b) Consider a sequence $x(n) = \{2, -1, 1, 1\}$ and T = 0.5 compute its DFT and compare it with its DTDT. [8+8]

4. (a) Explain the inverse FFT algorithm to compute inverse DFT of a N=8. Draw the flow graph for the same.
   (b) Compute the FFT for the sequence { 1, 0, 0, 0, 0, 0, 0, 0 } [8+8]

5. (a) An LTI system is described by the equation y(n)=x(n)+0.81x(n-1)-0.81x(n-2)-0.45y(n-2). Determine the transfer function of the system. Sketch the poles and zeroes on the Z-plane.
   (b) Define stable and unstable system test the condition for stability of the first-order IIR filter governed by the equation y(n)=x(n)+bx(n-1). [8+8]

6. Design a Digital IIR low pass filter with pass band edge at 1000 Hz and stop band edge at 1500 Hz for a sampling frequency of 5000 Hz. The filter is to have a pass band ripple of 0.5 db and stop band ripple below 30 db. Design Butter worth filler using both impulse invariant and Bilinear transformations. [16]

7. (a) Explain briefly the method of designing FIR filter using Fourier series method

(b) Design a FIR filter approximating the ideal frequency response
$H_d(e^{j\Omega}) = \begin{cases} e^{-j\alpha\Omega}, & for\ |\Omega| \le \pi/6 \\ 0 \quad , & for\ \pi/6 \le |\Omega| \le \pi \end{cases}$
Determine the filter coefficients for N=13. [6+10]

8. (a) Explain the different structures for realisation of IIR system. and explain how conversion can be made from direct form I structure to direct form II structure.

(b) Realize the given system in cascade and parallel form
$H(Z) = \frac{1+\frac{1}{2}Z^{-1}}{\left[1-Z^{-1}+\frac{1}{4}Z^{-2}\right]\left[1-Z^{-1}+\frac{1}{2}Z^{-2}\right]}$ [8+8]

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Code No: RR311102 **Set No. 4**

III B.Tech I Semester Supplimentary Examinations, November 2007
DIGITAL SIGNAL PROCESSING
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Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Consider a discrete linear time invariant system described by the difference equation:
y(n)-(3/4)y(n-1)+(1/8)y(n-2)=x(n))+(1/3)x(n-1)
Where y(n) is the output and x(n) is the input.
Assuming that the system is relaxed initially obtain the unit sample response of the system.
   (b) Find the:
      i. impulse response
      ii. output response for a step input applied at n=0 of a discrete time linear time invariant system whose difference equation is given by y(n) = y(n-1)+0.5 y(n-2)+x(n)+x(n-1). [16]

2. (a) Show that the frequency response of a discrete system is a periodic function of frequency.
   (b) Obtain the frequency response of the first order system with difference equation y(0) = x(n)+10y(n-1) with initial condition y(-1) = 0 and sketch it comment about its stability.
   (c) State and prove the frequency shifting property of Fourier transform. [5+6+5]

3. (a) Prove the following properties
      i. $arg[X(K)] = -arg[X((-K)_N)R_N(K)]$
      ii. $Im[X(K)] = -Im[X((-K))_N R_N(K)]$
   (b) If X(K) denotes the N-point DFT of N-Point sequence x(n), show that with N even and if x(n) = x(N-1-n) then X(N/2)=0. [8+8]

4. An 8 point sequence is given by x(n) = {2,2,2,2,1,1,1,1}. Compute 8 point DFT of x(n) by
   (a) radix - 2 D I T F F T
   (b) radix - 2 D I F FF T
   Also sketch magnitude and phase spectrum. [16]

5. (a) An LTI system is described by the equation y(n)=x(n)+0.81x(n-1)-0.81x(n-2)-0.45y(n-2). Determine the transfer function of the system. Sketch the poles and zeroes on the Z-plane.

(b) Define stable and unstable system test the condition for stability of the first-order IIR filter governed by the equation y(n)=x(n)+bx(n-1). [8+8]

6. Determine the system function H(Z) of the lowest order Chebyshev digital filter that meets the following specifications.

   (a) 1 db ripple in the passband $0 \leq |W| \leq 0.3\pi$

   (b) At least 60 db attenuation in the stopband $0.35\pi \leq |W| \leq \pi$. Use the bilinear transformation. [16]

7. (a) Design a low pass filter using rectangular window by taking samples of $\omega(n)$ and with a cut-off frequency of 1.2 radians/sec.

   (b) Compare the various window functions. [8+8]

8. (a) What are the basic elements used to construct the block diagram of discrete time system?

   (b) Construct the block diagram and signal flow graph of the discrete time system whose input-output relations are described by following difference equation

      i. $y(n) = 0.5x(n) + 0.5x(n-1)$

      ii. $y(n) = 0.25y(n-1) + 0.5x(n) + 0.75x(n-1)$ [4+12]

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